Volume 14 August, 1928 *Number 8*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Motor Transport Equipment
Heavy Duty Engine Lubrication

PUBLISHED MONTHLY BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

Insist
on all
of them !

5

Five Important Points

about

Motor Bus and Truck Maintenance

1 Properly designed Bearings.
2 Piston Rings that fit accurately.
3 A dependable Lubricating System.
4 A reliable Timing System.
5 The Right Kind of Oil.

The first four of these are highly important. But the fifth—*the right kind of oil*—is more important than all the rest.

Without oil, every one of the first four would wear out, break down, or cease to function.

So *oil* is important.

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MOTOR TRANSPORT EQUIPMENT

Heavy Duty Engine Lubrication

IN the extension of the automotive industry one of the outstanding features has been the development of the heavy duty engine for common carrier transportation service, viz.: as the power plant for the motor bus and motor truck.

During the few years immediately following the war freight and passenger loads imposed severe duty upon the existing railroads and interurban lines, for the countryside was developing in home sites as well as industrial communities. This meant the rapid and frequent moving of traffic—oftentimes into areas still distant from railway service.

The automobile had early proven its worth as a passenger carrier. The war developed the motor truck. The logical sequence was, therefore, to bring these vehicles into the active public utility class—the motor bus for the handling of passengers, the truck for the transportation of freight such as building supplies and foodstuffs.

So efficient did their inception prove, that today they are a vital factor in the maintenance of industrial production, home comforts and economic progress.

The operating conditions under which such equipment must function will usually be comparatively severe. Long distances are oftentimes traveled. Stops are infrequent and short especially in rural or interurban service, loads are high, and speeds equal to those which prevail in average automobile operation. Engine design has kept pace with the above in every detail, for service can only be as dependable as is the power plant.

In turn, however, the power plant will be decidedly dependent upon its manner of lubrication and the care which is used in selecting motor oils which will be capable of functioning successfully under the probable operating conditions which may be encountered. It is fitting, therefore, to study this matter of engine lubrication in detail, for insight into constructional features, design of lubricating systems and operating requirements will be most essential in the selection of motor oils which will function most effectively and lead to maximum engine economy.

PRINCIPLES OF OPERATION

The engine of the modern motor bus or truck is of the heavy duty four cycle type, equipped with sleeve or poppet valves. Both four and six cylinder construction are used, according to the make and service involved. To give rigidity, cylinder blocks and crankcases are frequently cast as a unit. There is a decided advantage to such construction in view of the fact that elimination of a bolting surface and the possibility of gasket failures will reduce the possibility of oil leakage. This is an economy from the viewpoint of oil consumption, as well as being an asset in preventing oil smears, especially on concrete road surfaces.

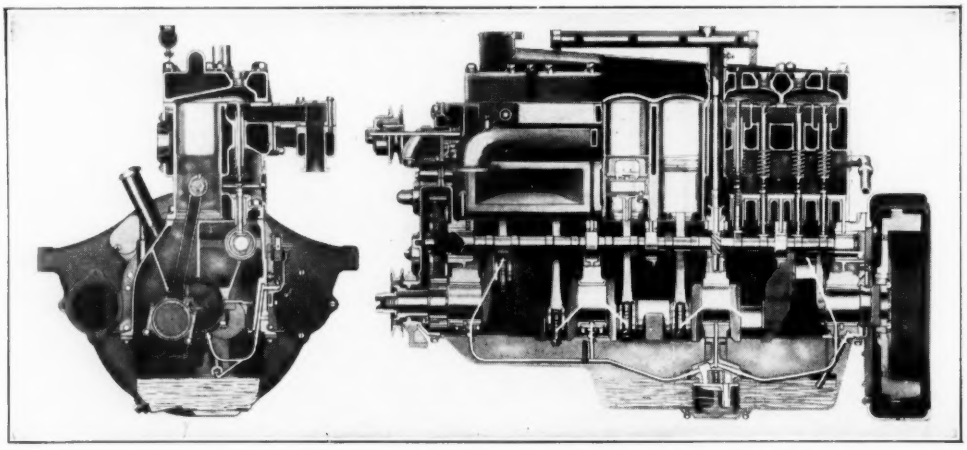
By virtue of the heavy duty involved and the frequently high operating pressures which may prevail, it is of the utmost importance to protect engine wearing elements by adequate cooling. In part this is brought about by flood lubrication of bearings. Cylinders, however, must receive added protection. It has been determined that water cooling is the most practicable method available. As a result all such

engines are built with water-jacketed cylinders to provide for free circulation of an adequate supply of cooling water.

Cooling must, of course, be as positive as possible. For this reason water circulation is brought about by pumping. The centrifugal type of pump is preferred for this purpose on the majority of bus and truck engines today.

ENGINE LUBRICATION

The intensive duty to which such engines will frequently be subjected also requires most positive and dependable lubrication of cylinders, bearings and all other wearing elements. To bring this about pressure lubrication has been adopted as standard on virtually all engines designed for such service. Just what parts are thus lubricated, however, will depend upon the design of the engine, but all main and connecting rod bearings, at least, will be pressure oiled.



Courtesy of Lycoming Manufacturing Co.

Fig. 1—Sectional view of the Lycoming Model "TS" six cylinder engine designed for motor truck and bus service. Lubricating system can be clearly followed.

In principle pressure lubrication provides for the pumping of oil from the reservoir or oil sump in the crankcase directly to all main or crankshaft bearings. From here it is forced through suitably drilled holes in the crankshaft to the crank-pin or connecting rod bearings.

Flow of oil from these points may vary. Where full pressure lubrication is deemed advisable the connecting rods will be drilled or suitable tubes installed to carry oil from the crank-pin bearings up to the wrist or piston pins, and frequently, where these latter are drilled, to the cylinder walls. Such oil as is delivered to the cylinder walls in this manner serves to supplement lubrication of the latter as brought about by the oil which is thrown up from the crank-pins.

All such engines are not full pressure lubricated, however. In many cases pressure ceases at the crank-pins, reliance being placed upon the oil thrown therefrom, to adequately lubricate the wrist or piston pins and cylinder walls.

Lubrication in this manner must not be confused with a splash system, for there is no provision for dipping of the connecting rods. In operation the entire crankcase is filled with an oily vapor or mist which is augmented at each throw of the crankshaft, provided, of course, that flow of oil through the main and crankshaft bearings is maintained in sufficient volume and under adequate pressure.

Course of Return Oil

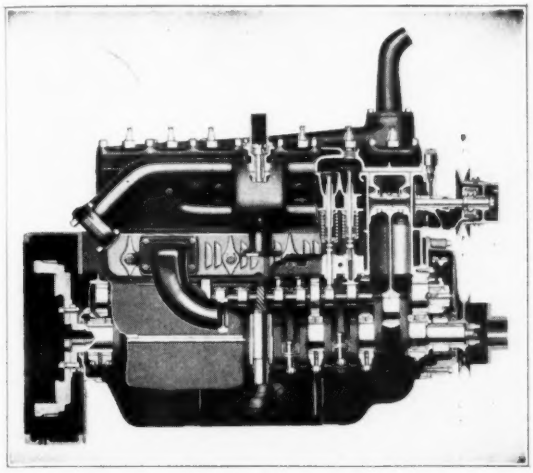
As oil passes through the various engine wearing elements or runs down the cylinder walls, there is normally provision for its return to the oil sump or reservoir in the crankcase.

Immediate re-circulation does not take place for lubricating systems are usually designed to allow a certain amount of rest. In a moving vehicle or vibrating engine such rest, however, is no assurance that all foreign matter will have a chance to precipitate or settle out, although heavier particles of dust or metal will usually do so.

In consequence it is frequently customary to install some type of filter which, in conjunction with the oil strainer adjacent to the pump, will effectively remove the greater part of any solid foreign matter which may be present. The useful life of the oil is thereby not only prolonged, but also the possibility of circulation of abrasive non-lubricating matter is materially reduced. In other words lubrication is rendered more dependable and the operation of the circulating system more positive.

It is not advisable, however, to expect too much of such equipment. Certain types will require cleaning or periodic renewal of the

filter element. The extent to which this may be necessary will of course depend upon the intensity of operation. And yet, some operators will feel that because their bus engines are equipped with oil filters, change of oil is but a



Courtesy of Continental Motors Corp.

Fig. 2—The Continental 18E speed truck engine showing in detail the operating mechanism. Pressure lubrication is maintained by a gear type pump in the base as shown.

secondary matter. It is far from being such, for there is still the matter of dilution or reduction in viscosity which must be considered.

Dilution is the direct result of condensation or deposition of a certain amount of unburned fuel on the cylinder walls. This eventually reaches the crankcase to enter the lubricating system, on account of the continued interchange of freshly sprayed oil with the lubricating film on the cylinder walls.

There are available means of more or less overcoming this in the form of oil rectifiers. Such devices are virtually distillation media, diluted oil being passed through them and subjected to the heat of the exhaust. The process is akin to refinement, the more volatile fuel fractions being vaporized and removed from the main body of the oil. The latter is then returned to the crankcase for re-circulation, fuel vapors being passed to the intake manifold.

Treatment in this manner will without a doubt be an adjunct to effective lubrication, and especially if carried out in conjunction with means of filtration, should increase the dependability and economy of the entire engine. Still and all, make-up oil must be added to take the place of that which has actually been burned during operation. Furthermore, crankcase draining and flushing should also be practiced, with complete and regular change of oil, for means of oil purification during operation is not absolute assurance that the original purity and lubricating ability of the oil is being maintained.

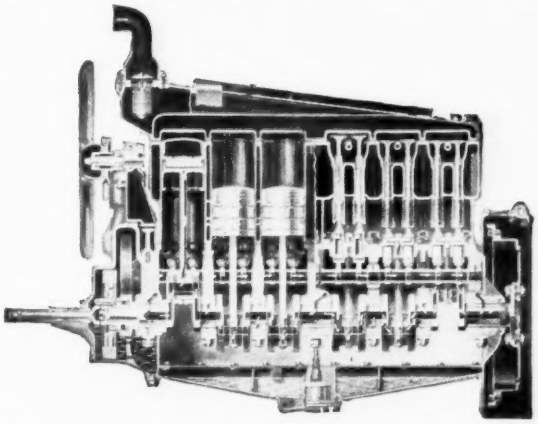
Especially will it be difficult for oil purification equipment to insure proper operation of piston rings, for carbon deposits developed around these latter cannot be as effectively sluiced out and drained to the crankcase for subsequent removal as can such deposits which are developed within bearing clearance spaces. In the latter flood lubrication is a decidedly positive method of washing out such non-lubricating matter.

PARTS TO BE LUBRICATED

The essential wearing elements in the automotive engine will include the cylinders, piston rings, and the bearings which carry the crank shaft, connecting rod pins and piston pins, also the timing gear equipment and valve operating mechanisms. By virtue of the fact that lubrication is entirely of an internal nature, with no opportunity afforded for checking oil flow to any particular part, every provision has been made to insure positive and dependable distribution from the moment of starting throughout any period of operation. The systems of lubrication described above will assure this, but only provided that they are maintained in proper operating condition and free from congestion.

To a great extent this will depend upon the degree of purity of the lubricating oil used, its manner of refinement and the care with which it is handled in transit, storage and usage.

Operating conditions will, in many instances, be decidedly severe, for average automotive transportation equipment must function regardless of temperature, weather or road con-



Courtesy of Pierce-Arrow Motor Car Co.

Fig. 3—The Pierce-Arrow six cylinder engine. Note the oiling system, bearing construction and design of pistons. Arrows indicate path of oil under pressure to all bearings.

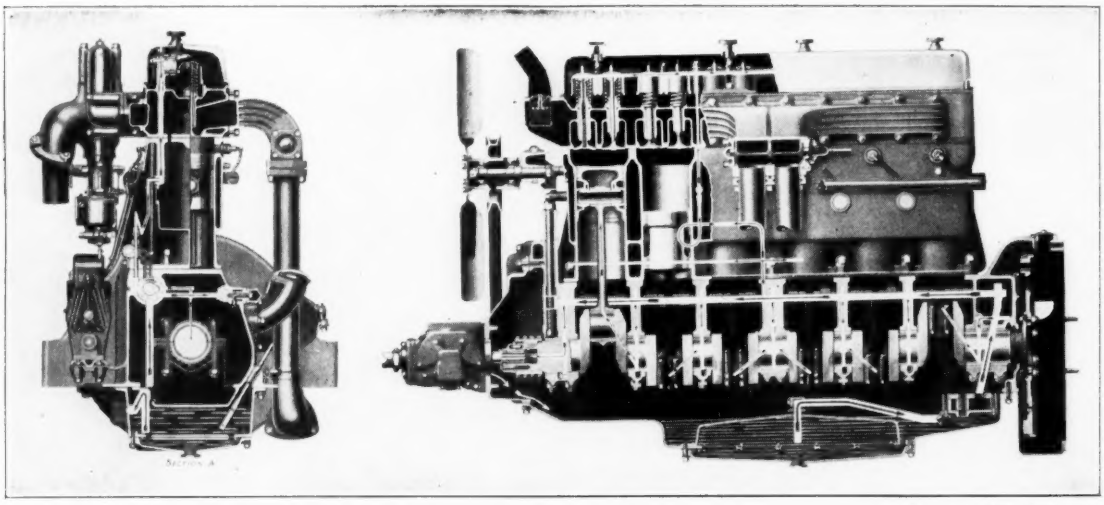
ditions. The motor bus especially is a common carrier and public utility and as such, must therefore, run on regular schedule, oftentimes under rigid supervision. The extent to which it will prove a profitable investment will largely

depend upon its ability to give relatively continuous service. Necessity for lay-up in the garage for engine repair, for example, will always be costly, not only from a labor and materials point of view, but also from a loss of revenue angle. Repair is chiefly necessitated by wear. In other words by failure to attain the proper degree of lubrication. As a result it may be safely stated that effective lubricant is the secret of economical motor bus and truck operation.

To assure this pistons are fitted with suitable rings, and bearings designed to permit of adequate circulation of oil throughout the clearance spaces.

As the age of the engine increases, this clearance may be increased due to wear. If the piston rings work freely, however, and the oil film is of suitable thickness, the clearance will be practically compensated for, and but little or no compression loss should result. But a set of sluggish rings due to accumulation of hard carbon deposits in the piston grooves will immediately cause more or less power and compression loss, unless perhaps the oil film is thick enough to fill up the clearance space effectively.

Lubricating oil in the combustion chamber will result in burning and frequently accumulation of excessive carbonaceous deposits on the spark plugs and piston heads and around the



Courtesy of The White Co.

Fig. 4—Lubricating system in front and side section of the White Bus Model engine. Arrows indicate clearly the path of oil. Full pressure lubrication is employed.

Function of Piston Rings

The part played by the piston rings in the operation of an automotive engine will be of decided interest. Their purpose is two-fold, viz.:

(a) To insure maximum power by maintenance of adequate compression within the combustion space above the piston, and

(b) To serve as flexible wearing elements between the cylinder walls and piston.

Piston rings are a direct adjunct to effective and economical cylinder lubrication in that by virtue of their sealing ability, they not only prevent an excessive amount of oil from passing to the combustion chamber, but also prevent abnormal oil dilution by fuel entry into the crankcase.

Piston rings furthermore compensate for the more or less uneven clearance which must exist between the pistons and cylinders, thus forestalling sticking or seizing of the pistons under the relatively high temperature of operation.

exhaust valves of a poppet valve engine, to materially reduce power output. Also this will cause the engine to knock under certain conditions of overload.

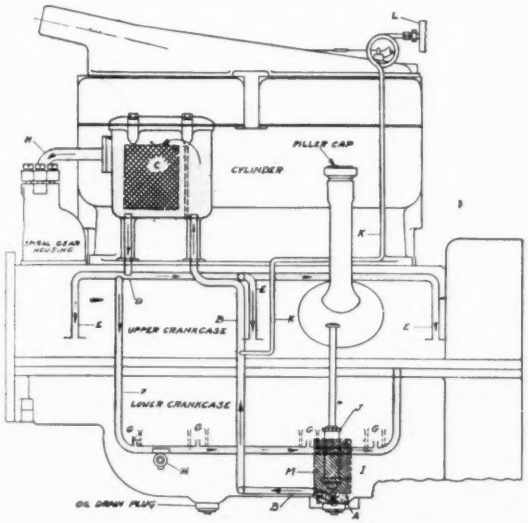
Fuel entry into the crankcase with resultant oil dilution has already been mentioned.

Factors Affecting Operation

Piston rings, however, can only function effectively provided that they are properly fitted, carefully installed, effectively lubricated and kept free from deposits which might affect their springiness. Free movement is of most decided importance, as sticking or any reduction in ability to spring may lead to oil pumping or blow by. The former involves entry of oil into the combustion spaces above the pistons; blow-by in turn implies loss of compression and possible leakage of fuel into the crankcase.

Fitting and installation are, of course, mechanical matters. In a new engine, or one which is functioning on its original rings, it is fair to assume that the installation as made by

the builder has been correct. Where rings are to be renewed, however, all work connected therewith should be supervised by the garage foreman or master mechanic.



Courtesy of International Motor Co.

Fig. 5—The Mack engine oil circulating diagram. Arrows indicate oil flow. A—Oil Circulating Pump—located in Crankcase Sump. B—Oil Pipe to Top Tank. C—Oil Tank and Filter Screen. D—Oil Distributing Pipe for Main Bearings. E—Oil Branch Pipes to Main Bearings. F—Oil Distributing Pipe to Troughs. G—Oil Troughs for Crankpin Lubrication and Splash. H—Oil Overflow Pipe Lubricating Timing Gears. I—Oil Reservoir—Lower Crankcase. J—Oil Level Indicator. K—Oil Pipe to Pressure Indicating Gage on Dash. L—Oil Pressure Indicating Gage on Dash. M—Oil Pump Filter Screen. N—Emergency Oil Level Cock.

From this point on the problem is virtually to prevent accumulation of deposits around or in back of the rings which would tend to cause them to become stuck in the piston grooves or to fail to spring and seal properly. Development and maintenance of an adequate film of oil on the cylinder walls and ring surfaces can be entirely relied upon in any engine unless the lubricating system is functioning improperly. Temperatures, however, especially at the top of the stroke will be comparatively high, although normally they will not exceed 300 to 350 degrees F. With certain grades of motor oils, nevertheless, these will be sufficient to cause more or less decomposition with resultant development of gummy residual matter. There will always be possibility of such matter working into the ring grooves to subsequently impair the operation of the rings. Once started, engine efficiency and lubrication economy will commence to drop off, being reduced more and more as the rings continue to fail in their intended duty.

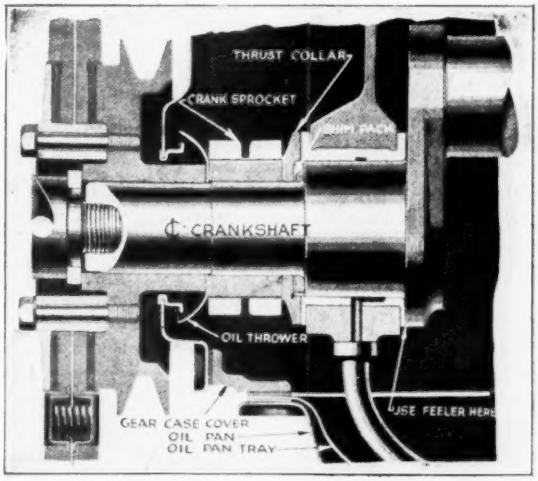
By careful choice of properly refined oils, however, which show a minimum of carbon residue content, the possibility of faulty action of piston rings can be markedly reduced, especially where such residues are of a light, fluffy or non-gumming nature with less tendency to adhere to the rings or penetrate within the piston grooves.

Bearing Construction

Usual bearing construction in the automotive engine involves plain or sleeve type bearings virtually throughout. There is a direct relationship between this type of bearing and pressure lubrication, by virtue of the clearance space available which can be kept flooded with oil.

A combination of flood and pressure lubrication is a most positive way to assure continued and dependable maintenance of the oil film in the clearance space of a sleeve type bearing, with the minimum reduction of bearing area by oil grooving. As a result, the main, crankshaft and piston pin bearings in the average bus or truck engine will usually be but scantily grooved, or frequently not at all.

Main and crankshaft bearings especially are usually of the two-part variety. The junction of the top and bottom halves must therefore be considered. It is general practice to round off the sharp edges just sufficiently to prevent oil scraping. In addition, more or less of an oil groove is thereby formed to facilitate distribution of oil along the entire length of the bearing surfaces. Flow of oil from the point of delivery at the center is outward through the clearance space towards each end of the bearing and thence through suitable oil ducts to adjacent bearings, according to the type of lubricating system, or to the cylinder walls and piston pin bearings by the action of centrifugal force.

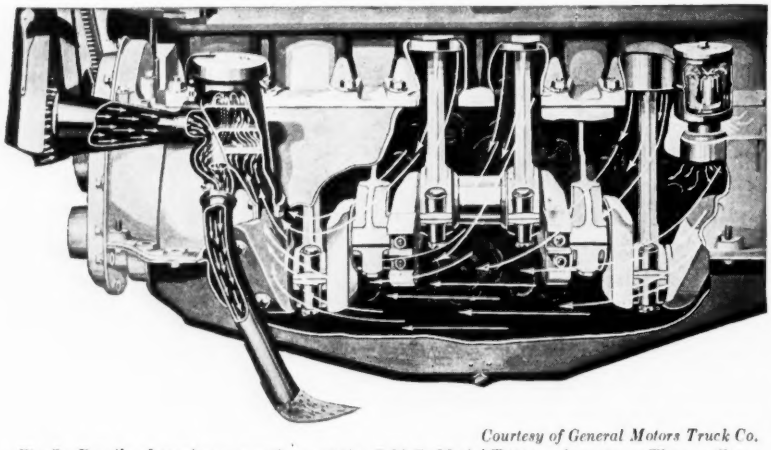


Courtesy of Continental Motors Corp.

Fig. 6—Front main bearing construction on the Continental engine showing provisions for lubrication.

The possibility of entry of abrasive foreign matter and the absolute necessity for prevention of accumulation in any part of the lubricating system have been decided factors in

leading to the adoption of combined flood and pressure lubrication. At the usual pressures which prevail, say up to a maximum of 40 pounds per square inch, and with the volume of oil involved, an effective washing action is brought about. In fact, in a properly designed lubricating system unless an oil of high gum-



Courtesy of General Motors Truck Co.

Fig. 7—Details of crankcase ventilator of the G.M.C. Model T-20 truck engine. The ventilator works on the ejector principle.

ming tendencies is used, there will be practically no chance for foreign matter to accumulate anywhere but in the crankcase or perhaps around the piston rings, or within piston pin clearances. Where these latter are full pressure lubricated, they too will be supplied with a flood of oil under adequate pressure to insure the same protection against accumulation of foreign matter deposits.

PROBLEMS INVOLVED

Engine lubrication in the motor bus or truck may be impaired and abnormal cylinder and bearing wear developed by

(a) excessive reduction in viscosity or body of the oil.
(b) clogged oil ducts due to accumulation of dirt or carbon, or
(c) faulty oil flow in cold weather when the oil is too sluggish to flow readily, especially on starting.

Each may occur independently of the other, therefore individual consideration of the cause will usually be necessary. The result in any case, however, will be the same, viz.: breakdown of the lubricating film and the probability of metal-to-metal contact with marked increase in wear and temperature of operation.

The Cause and Effect of Dilution

Reduction in viscosity or body of the lubricating oil is brought about by dilution, as has already been stated. It will be interesting to study the cause and effects in more detail.

In the average running of any automotive engine, crankcase dilution will occur at practically all times. It may be especially prevalent in cold weather. Normally, however, it will go only so far, apparently reaching an equilibrium point after a sufficient length of time, notwithstanding the entry of a certain excess of the lighter diluents whenever the choke is used. Continued choking, however, may lead to a temporary condition of abnormal dilution, where the diluent becomes the major part of the lubricating mixture. At such a time, sudden application of the load will result in the lighter or diluent portions being rapidly evaporated from the film on the cylinder walls due to rapid heating of the cylinders. This may cause the lubricating film to be reduced sufficiently in thickness to result in scored cylinders and serious loss in compression.

Experiments have shown that while the state of equilibrium between the lubricating oil and the lighter fuel portions will vary with the nature of the constituents, it will balance itself of its own accord if sufficient time is allowed; that is, if an equilibrium condition of 20 per cent diluent is normal for the case in question, if 40 per cent diluent is started with in the crankcase, the lubricating mixture will tend to return to its state of equilibrium.

How Bearings Are Affected

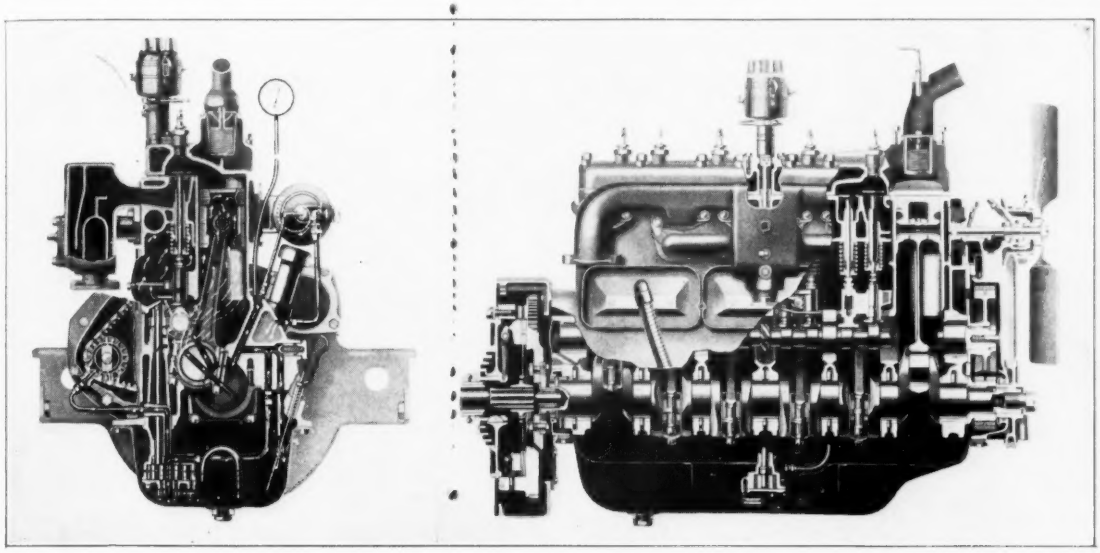
The usual amount of reduction in viscosity due to dilution in the average engine today may, of course, tend to promote the pumping of oil by shafts or pins in their rotation, inasmuch as lighter fluids will lend themselves to more ready handling, if it can be called such, but only under lower speeds. The higher the rubbing speeds the lower will be the pumping efficiency of the bearing. Furthermore, increase in the rubbing speed between a journal and bearing causes an increase in frictional heat.

As a result a diluted engine oil, under higher speeds and normal operating temperatures must possess very high lubricating ability and be as free as possible from carbon or other foreign matter if it is to furnish a suitable film to protect the bearings. Only can this be obtained by the most careful refinement, and the rendering of the original oil as pure as possible.

Unless the oil is given every attention in its refinement, there will be considerable possibility of it being broken down in service, especially where the frictional heat developed in

the bearing is not being adequately carried away by the oil itself. The ideal in automotive bearing construction is to plan for practically the entire removal of frictional heat by the oil, thereby preventing this heat from reaching cylinder heads, around the rings, and on the valves and seats, but also in the crankcase or oil sump itself.

While such deposits are more generally attributed to incomplete combustion of the



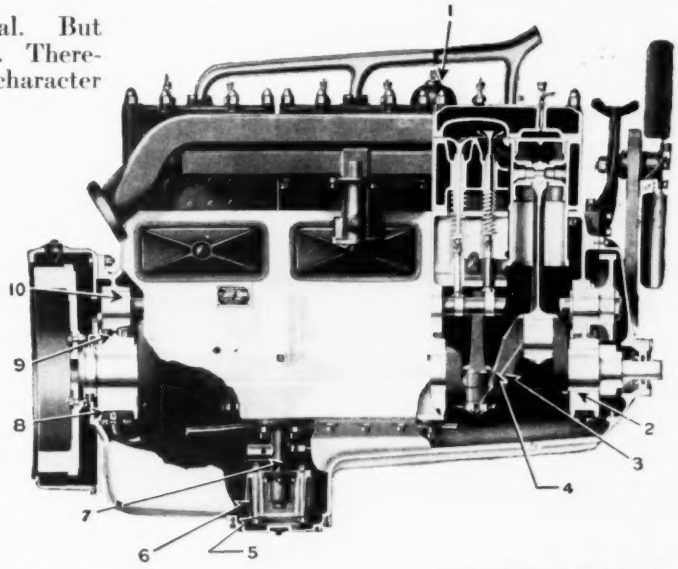
Courtesy of Dodge Brothers, Inc.

Fig. 8—Details of the Graham Bros. engine showing in particular the provisions for pressure lubrication in the front sectional view, and general construction in the side view.

either the bearing surface or journal. But this ideal is not actually obtainable. Therefore, the oil must be of such a character as to:

1. *Be capable of maintaining the requisite lubricating film.*
2. *Resist the breaking down effects of heat.*
3. *And develop as little hard carbon as possible if subjected to continued service under overheated conditions.*

Carbon in an engine combustion chamber on valves, piston heads, on spark plugs or in ring grooves, etc., is a detriment from the viewpoint of ultimate power developed. In bearing clearance spaces, however, it may, in addition, result in mechanical failures due to an impairment of circulation of the lubricant by the clogging of grooves or oil ducts. It must, therefore, be guarded against with the utmost care.



Courtesy of Waukesha Motor Co.

Fig. 9—The Waukesha 6-cylinder Bus and Truck engine showing details pertinent to lubrication as follows: (1) Series type H-W Oil Filter; (2) Bronze back babbitt lined bearings; (3) Four-bearing chrome nickel crankshaft; (4) Pressure circulated oil distributed by drilled passages in crankshaft; (5) Vertical self-cleaning oil screen; (6) Patented oil screen shield to prevent pump sucking air when oil is low or very cold; (7) One piece direct driven submerged oil pump; (8) Steel bearing caps; (9) Main bearing cap studs; (10) Four-bearing camshaft with integrally forged cams.

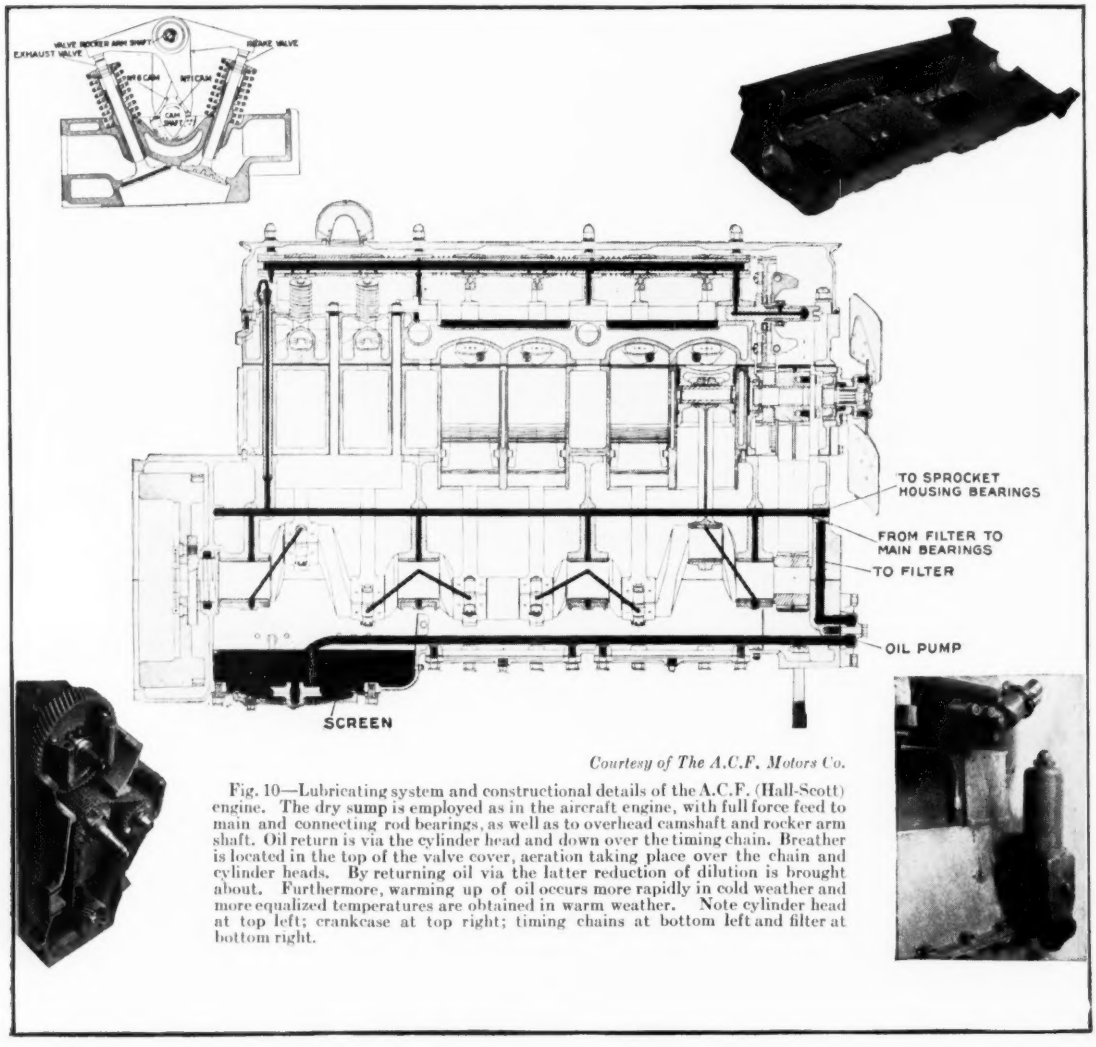
Formation of Deposits

In connection with this matter of dilution it is decidedly necessary to keep in mind the relation which it bears to excessive carbon formation, or the building up of so-called carbon deposits, not only on spark plugs, pistons, fuel, to the use of excess lubricating oil, or to the entry of silicious foreign matter such as road dust via the air intake or breather pipe, we must not lose sight of the fact that dilution is also a pertinent contributor. In other words,

it is perfectly evident that the lighter the lubricant or the thinner the film on the cylinder walls the more readily will it splash or succumb to the wiping effects of the piston. This will, of course, increase the possibility of pumping or forcing of the lubricating film up into the combustion chamber where it will be ultimately burned to result in the development of more or less carbon.

To what extent this may occur will, of course, depend upon the residual carbon content of the oil. Where an oil burns cleanly the amount of such deposits will be relatively small. Furthermore, if the oil is properly refined and adapted to the purpose such carbonaceous matter will be soft in appearance, low in quantity and comparatively easy of removal.

Over extended periods of operation, however, carbon deposits, whatever their nature, will be bound to increase. Furthermore, where pumping or forcing of a certain amount of lubricating oil into the combustion chamber occurs the ultimate oil consumption will be higher, with a reduction in the mileage developed per gallon.



Courtesy of The A.C.F. Motors Co.

Fig. 10—Lubricating system and constructional details of the A.C.F. (Hall-Scott) engine. The dry sump is employed as in the aircraft engine, with full force feed to main and connecting rod bearings, as well as to overhead camshaft and rocker arm shaft. Oil return is via the cylinder head and down over the timing chain. Breather is located in the top of the valve cover, aeration taking place over the chain and cylinder heads. By returning oil via the latter reduction of dilution is brought about. Furthermore, warming up of oil occurs more rapidly in cold weather and more equalized temperatures are obtained in warm weather. Note cylinder head at top left; crankcase at top right; timing chains at bottom left and filter at bottom right.

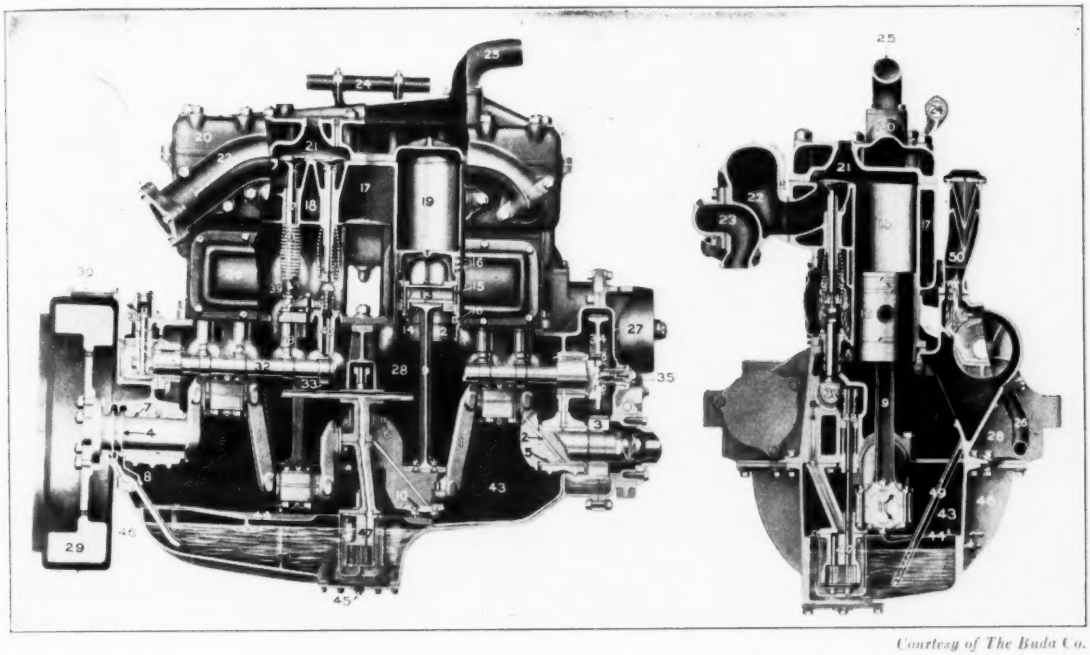
In addition, dilution may involve the possibility of a certain amount of loss of compression due to impairment of the piston seal when the viscosity of the oil is so reduced that the lubricating film is comparatively readily wiped off by the piston rings.

Adequate Fluidity Essential

In cold weather especially the efficiency of any automotive engine from a lubricating viewpoint will be largely dependent upon the operating temperature, and viscosity of the lubricating oil used. In turn the viscosity is a function of the temperature. In other words, under colder atmospheric conditions, the viscosity of a lubricant will increase, resulting in a lower

degree of fluidity and involving greater internal fluid friction.

Naturally this will cause a reduction in lubricating efficiency and necessitate a greater consumption of power to bring and maintain the vehicle at the desired speeds.



Courtesy of The Buda Co.

Fig. 11—Sectional views of the Buda engine. Pertinent parts pertaining to lubrication are: (2) The oil passage to connecting rod bearing; (4) The rear bearing oil retainer rings; (8) The oil retainer; (43) The oil pan; (44) The oil pan trough; (45) The oil drain plug; (47) The oil pump assembly; (48) The oil pump drive shaft; (49) The oil level gauge assembly; and (50) The breather.

If the normal viscosity of the oil at 210 degrees F. be relatively high it is perfectly clear that under exceedingly low temperatures this oil might become so sluggish as to be relatively difficult to pump. It is for this reason that lighter, lower viscosity oils are used in the winter than in the summer.

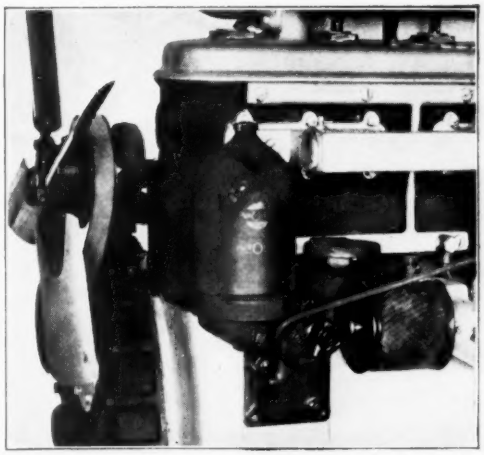
Importance of Low Pour Test

Another reason is that a heavier lubricant congeals far more rapidly when subjected to cold, than a lighter oil. In the refining of motor oils, it is possible to vary the pour test or temperature of congealment to some extent. Naturally the lower this temperature, or in other words, *the lower the pour test, the more suitable and dependable will the oil be for cold weather operation*, other factors being equal. In view of this, the operator should always endeavor to obtain as low a pour test oil as possible for winter usage.

In general winter operation, the viscosity of the motor oil should be reduced so as to give approximately the same lubricating efficiency as in warm weather.

It can be appreciated that a lubricant which the pump might handle with difficulty due to excessive viscosity or too high a pour test, might give rise to difficulty in starting, or be the cause of all manner of engine troubles, such as burned bearings, scored cylinders or seizing of certain parts due to its being too viscous to be properly transmitted through the lubricating system.

The claim may be advanced that the more or less common condition of crankcase dilution will soon cause thinning down of such a lubricant to enable it to flow properly. Crankcase dilution, however, is an extensive variable, and

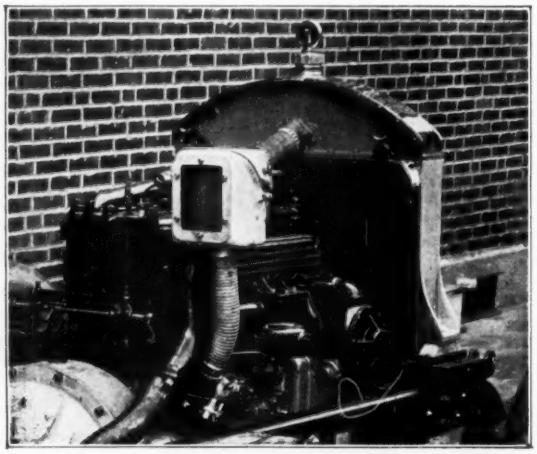


Courtesy of Yellow Truck & Coach Mfg. Co.
(Subsidiary of the General Motors Corp.)

Fig. 12—The Yellow Truck and Coach 6-cylinder 4½ x 5½ inch engine showing Pur-O-lator for continuous oil filtration in service.

it should never be depended upon to perform any such function.

If, in the opinion of the operator, the atmospheric temperature is so low as to render an otherwise suitable motor oil temporarily so sluggish as to be incapable of proper lubrication, he should insure lubrication by warming up his cold engine very slowly, until the heat generated has reduced the viscosity of the oil sufficiently to enable it to be properly pumped.



Courtesy of International Motor Co.

Fig. 13—View of a Motor Bus and Truck engine showing the air filter which is so essential in preventing entry of abrasive dust.

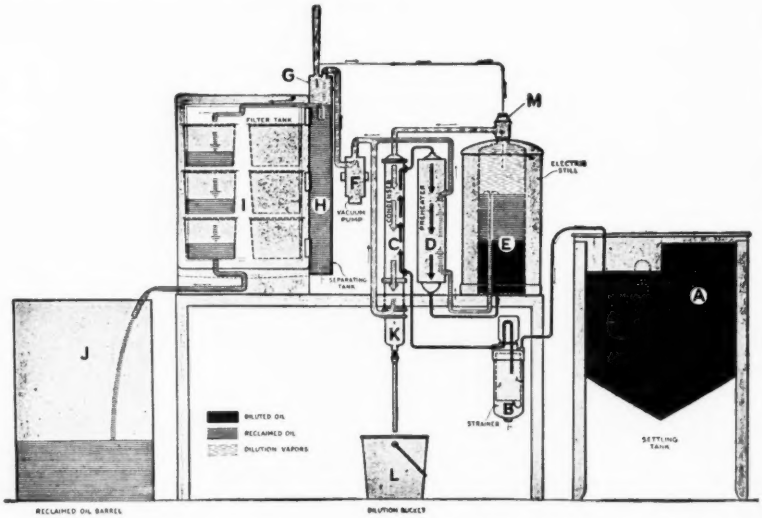
RECLAMATION OF USED OILS

As an adjunct to maximum economy in the operation and lubrication of the motor bus or truck engine, proper reclamation of used motor oils will be a most decided factor. The service to which an oil is put in such an engine is exacting, and the possibilities of contamination are frequently numerous. But actual loss of lubricating ability does not occur; it is only counteracted by the development of non-lubricating matter taken into the engine during operation, or resulting from burning of a certain amount of oil at the upper parts of the cylinder walls. This latter occurrence, however, should normally not be extensive if due care has been exercised in original selection of the oil, with consideration of the temperatures which may be developed.

In this regard it must be realized that a bus or truck engine will usually develop more heat than the average engine of an automobile. As a result, crankcase temperatures will be proportionately higher and the tendency of viscosity decrease reduced. These facts have been fully realized by the reputable petroleum refiner, however, and every effort is made to produce lubricating oils for such service which will be heat resisting and of sufficiently heavy body to assure adequate lubrication under even the most intensive operating conditions.

Frequency of Changing Oils

The question of just how long a bus or heavy duty truck engine can or should run between oil changes will constantly arise. It is virtually impossible, however, to settle it in a manner satisfactory to every phase of operation. Conditions will vary too widely. Normal operation over level streets in the city, for example, will be less severe than where a bus must run at high speed for long distances, or be called upon to pull up heavy grades at frequent intervals. Operation of this latter nature may be expected to develop higher temperatures and require a heavier bodied oil. Furthermore, there would be greater possibility of oil contamination. Therefore, oil changing should be practiced more frequently.



Courtesy of Skinner Automotive Device Co., Inc.

Fig. 14—The Skinner Oil reclaimer for purification of crankcase drainings. "A" is a settling tank through which oil passes on way to water separator "B" and condenser "C". From here oil passes to preheater "D" and thence to a still "E" where lighter fractions are driven off. These vapors are condensed in "C" through which cool oil passes, being then discharged via trap "K" to container "L". Refined oil is drawn by pump "F" and delivered to vapor separating tank "H". "I" is a filter chamber, through which oil is finally passed.

2,500 to 3,000 Miles Approved by Many

Where conditions of operation are deemed extreme, certain operators will regard daily oil changing advisable. Under such routine, oil is drained at night when a bus comes in from its

day's run. This oil can then be reclaimed and reused, in some instances being returned to engines with perhaps but little or no fresh oil. Such practice disregards mileage entirely. In other words, the common theory of oil changing in automobile service of say every 750, 1,000 or 1,500 miles, according to the type of engine, is given practically no consideration.

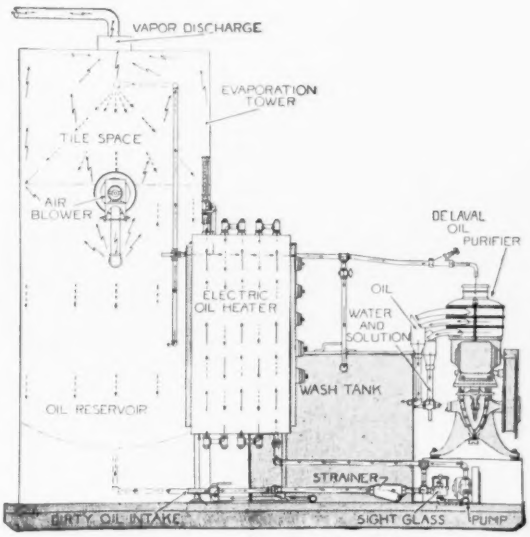
Change of oil daily, however, while excellent insurance, will be frequently impracticable due to labor conditions, garage facilities, or the amount of time involved. As a result, the mileage basis is most generally preferable and it is safe to say most frequently followed by the average operator. Experience has indicated that a frequency of every 2,500 to 3,000 miles can be safely adopted unless service is unduly severe.

An essential proviso to such practice, however, is that the oil be a reputable product, which has been properly refined, and which has a minimum carbon residue content. With such an oil it has been proved that entirely dependable operation can be assured by adding make-up oil daily to maintain the proper crankcase level.

The Oil Filter a Salient Factor

One of the chief reasons for such dependability in the lubrication of the bus or heavy duty truck engine is the extent to which the oil filter has been adopted as a means of continuous oil protection. The majority of these engines today will be equipped with such a device. Those types of filters which have proven their efficiency are capable of removing practically all solid or abrasive foreign matter.

The possibility of scoring or wear of bearing elements, or clogging of the lubricating system is therefore decidedly reduced. In fact, analysis of numerous samples of such oils which have been in service for 3,000 miles has shown that practically the only contaminating components are those heavy ends of the fuel which have brought about dilution. As a rule these will range from 5% to 20%, according to the grade of gasoline which has been used, and the degree to which proper carburetion has been brought about.



Courtesy of The De Laval Separator Co.

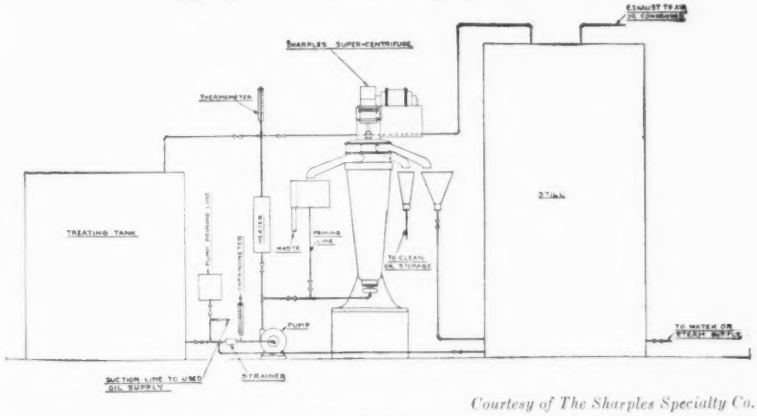
Fig. 16—Details of the De Laval crankcase oil purification system. By careful heating, washing with chemicals to coagulate carbon, evaporation and centrifugal action, the oil is reconditioned or freed of impurities and rendered suitable for re-usage.

Principles of Oil Reclamation

It is a general theory that continued usage of lubricating oils will result in temporary impairment of lubricating value rather than actual breakdown. This is primarily due to the fact that an oil becomes contaminated with non-lubricating foreign matter rather than dissociated from a chemical point of view.

Where heat is involved, however, as in the automotive engine, a certain amount of distillation may occur in some lubricating oils. In the opinion of many this will be looked upon as breakdown of the oil. This is erroneous, for dissociation of the lubricating oil occurs to but a very slight degree. Actually, partial distillation involves the vaporization of those more volatile hydro-carbon fractions which may have been contained in the original oil.

The more highly refined lubricating oils of reputable brands will show the least tendency towards such reaction. In other words, these products are refined to very close fractionation; they, therefore, contain but very slight per-

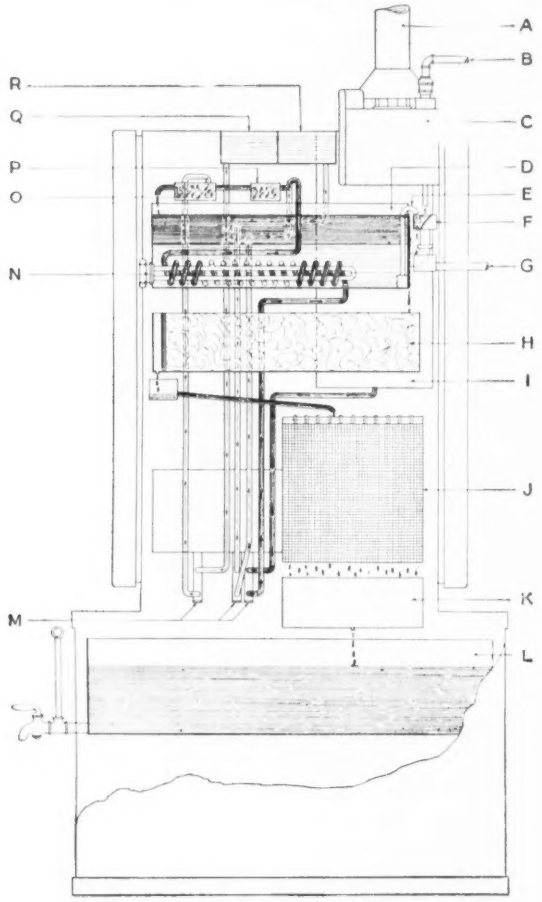


Courtesy of The Sharples Specialty Co.

Fig. 15—The Sharples process for recovery of oil from crankcase drainings, involving heat treatment and passage through a centrifuge.

centages of highly volatile constituents, and are capable of satisfactorily withstanding the average temperatures of bus engine operation.

Oils of this character are the most economical to use, both from the viewpoint of their ability



Courtesy of The Hilliard Corp.

Fig. 17—The Hilliard "Refinoroil" for reclamation of motor and bus oils. Two steps are involved, viz.: clarification and rectification. Oil, after heating, is first chemically treated to develop a sludge which removes solid and other impurities and leaves the oil in clarified state. The sludge settles rapidly, being removed by a constantly changing underlying body of water. Diluents are then removed by passing the clarified oil in a thin film over electrically heated rectifying plates "J" exposed to a current of air. Essential parts are as follows: (A) Vent Pipe; (B) Water Inlet; (C) Safety Device; (D) Clarifying Tank; (E) Sludge Evacuator; (F) Cup; (G) Drain Connection; (H) Soap Catcher; (I) Supply Tank; (J) Rectifying Plate; (K) Heat Interchanger; (L) Clean Oil Tank; (M) Pump; (N) Immersion Heater; (O) Silicate Mixer (P) Gelco Mixer; (Q) Silicate Container; and (R) Gelco Container.

to protect the wearing elements, as well as the small amount of make-up required due to the lesser degree to which loss during operation may occur.

Methods Involved

Dilution, however, cannot be avoided, regardless of how good the lubricating oil may be. It is a function of operation, although it may be decidedly contingent upon operating conditions, carburetion and the volatility of the gasoline used, as has already been mentioned.

The purpose of reclamation or reconditioning of bus oils at the period of crankcase draining is two-fold, viz.: to remove such diluent portions of the fuel, and to free the oil of non-lubricating solid, gummy or abrasive foreign matter which may not have been removed by the oil filter, provided, of course, that one is installed. It is therefore entirely possible and usually good economical practice to save crankcase drainings and subject such oil to a recognized system of reclamation.

The above will usually involve heat treatment, and subsequently centrifugal, or filter or chemical treatment, according to the type of equipment involved.

Heat Treatment a Factor

Heat treatment of a diluted lubricant may rightfully be expected to bring the oil back to very nearly its original viscosity, according to the extent to which the diluent content is removed.

If during reclamation the used oil is heated until all the diluent fractions are driven off, the viscosity of the remaining oil will, in fact, be probably higher than that of the original product.

Numerous tests have proven that the resultant viscosity will show an average increase of from five to fifteen seconds Saybolt at 210 degrees F., according to the degree of refinement of the original oil. As a typical example of this it is interesting to cite an instance wherein the oil showed an original Saybolt viscosity of 95 seconds Saybolt at 210 degrees F. After 3,000 miles service, however, and suitable reclamation during which process practically all contained diluent was distilled off, the resultant viscosities of several samples from different engines showed a Saybolt viscosity of from 100 to 110 seconds Saybolt at 210 degrees F.

Where reclaimed oil is to be used as make-up, which is the most usual custom, it is beneficial to have a certain amount of increase in viscosity, for this will compensate in part for such dilution as may have occurred.

It is quite possible, however, to unconsciously allow the process of reclamation distillation to go too far; in other words, to cause actual distillation to commence from the lubricant itself. In view of the fact that this will cause both loss of oil and marked increase in body, it is obviously bad practice. To prevent such occurrence the temperature of reclamation must, therefore, be very accurately controlled; the range being from 300 to 450 degrees F. according to the type of reclamation system employed and the recommendations of the builders.

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